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High Order Finite Volume Schemes for the Simulation of elastic Wave Propagation

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The simulation of wave propagation in an elastic medium requires numerically solving a hyperbolic system of partial differential equations in non-conservative form. In the past, different numerical methods including finite differences, finite volumes, spectral methods, finite elements, or spectral elements have been developed in order to solve these equations accurately. Unfortunately, the finite volume method has only been applied to this particular problem as a low order scheme leading to severe numerical diffusion. Here we present a high order finite volume approach mainly developed in the field of computational fluid dynamics. In fact, it can be shown that the proposed finite volume schemes can be formulated up to an arbitrary high order accuracy in time and space. In this work, we introduce this new approach (ADER) and apply it to solve the elastic wave equations in heterogeneous media in two space dimensions. Due to a weighted essentially non-oscillatory (WENO) reconstruction of the velocity and stress variables numerical diffusion as well as dispersion of the propagated waves can be avoided to a large extent providing high resolution results. The numerical examples include transmissive and free surface boundary conditions and confirm the good performance of the proposed scheme. Furthermore an extension to unstructured triangular meshes is addressed.